PART - 1

GENERAL WORKMANSHIP, MATERIAL AND DESIGN REQUIREMENTS FOR PLANT

Contents

1. Introduction 1
1.1 Materials General 2
1.2 Workmanship General 3
1.3 Design Life 3
1.4 Welding 4
1.5 Castings 4
1.6 Instrument Components 5
1.7 Safeguarding of Machinery 5
1.8 Rating Plates, Nameplates and Labels 5
1.8.1 Indoor Type Labels 5
1.8.2 Weatherproof Labels 6
1.8.3 Name and Rating Plates 6
1.9 Lubrication 6
1.10 Initial Changes of Oil, Grease, etc. 7
1.11 Non-metallic Materials 7
1.12 Engineering Hardware 7
1.13 Instruments 8
1.14 Noise and Vibration 9
1.15 Pipe work and Layout 10
1.16 Gaskets and Joint Rings 10
1.17 Steelwork 11
1.18 Protection and Packaging for Transportation 11
1.19 Steel Structural Works

PART 1

GENERAL WORKMANSHIP, MATERIAL AND DESIGN REQUIREMENTS FOR PLANT

4 Introduction

This part of the Employer's Requirements sets out the standards of materials, workmanship and design to be used by the Contractor for Plant. Reference to any specific material or equipment does not necessarily imply that such material or equipment is to be included in the Works.

All Plant used for the Works shall, unless otherwise specified, comply with the provisions of this part.
The names of the manufacturers of materials and equipment proposed for incorporation in the Works together with performance, capacities, certified test reports and other significant information pertaining to the same, shall be furnished when requested for consideration by the Engineer, who shall have power to reject any parts which in his opinion are unsatisfactory or not in compliance with the Specifications and such parts shall be replaced by the Contractor at no extra cost to the Employer.

4.1 Materials General

All materials incorporated in the Works shall be the most suitable for the duty concerned and shall be new and of first class commercial quality, free from imperfections and selected for long life and minimum maintenance.

All submerged moving parts of the Plant, or components such as pins and spindles, for example, of the submerged moving parts or the faces in contact with the parts shall be of corrosion resistant metals. All parts in direct contact with various chemicals, shall be completely resistant to corrosion, or abrasion by these chemicals, and shall also maintain their properties without aging due to the passage of time, exposure to light or any other cause.

Where "stainless steel" is specified or used it shall have resistance to atmospheric corrosion not less than that provided by B.S.970, Grade 410 S21 for forgings and B.S. 3100, Grade 410-C-21 for castings. Particular attention shall be made to the prevention of seizure by fretting where two corrosion resistant metals are in contact, by the selection of materials of suitable relative hardness and surface finish and the application of lubricants. Where bronze is specified or used it shall be zinc free, to B.S. 1400, Group B- PB1.

Particular attention shall be paid to the prevention of corrosion due to the close proximity of dissimilar metals. Where it is necessary to use dissimilar metals in contact, these shall be selected so that the bimetallic corrosion is as low as possible. The publication by H. M. Stationery Office (in the U.K.) entitled "Corrosion and its Prevention at bimetallic Contacts" shall be used as a guide.

4.2 Workmanship General

Workmanship and general finish shall be of first class commercial quality and in accordance with best workshop practice and shall provide what is generally recognised as waterworks finish as defined elsewhere.

All similar items of plant and their component parts shall be completely interchangeable. Spare parts shall be manufactured from the same materials as the originals and shall fit all similar items of plant. Machining fits on renewable parts shall be accurate and to specified tolerances so that replacements made to manufacturer's drawings may be readily installed.

All equipment shall operate without excessive vibration and with minimum of noise. All revolving parts shall be dynamically balanced so that when running at all operating speeds and any load up to the maximum there shall be no vibration due to lack of balance.

All parts which can be worn or damaged by dust shall be totally enclosed in dust proof housings.

Dynamic balancing of rotary components shall be to the relevant standards. All bearings shall have L-10 rating life of minimum 16,000 hours.

All instruments used for the works whether for permanent installation or for checks/inspection at the Manufacturer's works or for checks/inspection at site shall be calibrated using standard reference instruments from institutions recognised by the Government such as "Institute for Design of Electrical Measuring Instruments (IDEMI), Mumbai.

All outdoor instruments shall be provided with locked, galvanised metallic enclosures of 2 mm thickness, suitably painted.

4.3 Design Life

All materials and equipment shall be designed for long life and shall be suitable for continuous 24 hour per days operation for prolonged periods with a minimum of maintenance and the Contractor may be called upon to demonstrate this for any component either by the service record of similar equipment elsewhere or by records of extensive type tests.

Routine maintenance and repair shall as far as possible, not require the services of highly skilled personnel.

Except for consumable items such as rubber bushings, gland packings, carbon brushes etc. which normally require replacement more frequently, no part subject to wear shall have a life from new to replacement or repair of less than three years of continuous normal operation and where major dismantling is required to replace a part, such life shall be not less than ten years.

4.4 Welding

In all cases where welds are liable to be highly stressed the Contractor shall supply to the Engineer before fabrication commences detailed drawings of all welds and weld preparations proposed. No such welding shall be carried out before the Engineer has signified his approval of the details proposed. No alteration shall be made to any previously approved detail of weld preparation without prior approval of the Engineer.

Welding shall comply with B.S 5135.

Approval of welding procedures shall be as per B.S. EN 288-3:1992. Welders shall be qualified to B.S. EN 287-1:1992. All aspects of fabrication and examination procedures including pre/post heating treatment, electrodes, non-destructive Tests (NDT) shall be subject to approval of the Engineer.

Following codes shall apply for the NDTs:

B.S. 2600 : Radiography;
B.S. 3923 : Ultrasonic Test;
B.S. 6072 : Magnetic Particle Test;
B.S. 6443 : Penetrant Test.

4.5 Castings

All cast iron shall be of standard grey close-grained quality to B.S.1452: 1977 Grade 220 or better. The structure of the castings shall be homogeneous and free from non-metallic inclusions and other injurious defects. All surfaces of

castings which are not machined shall be smooth and shall be carefully fettled to remove all foundry irregularities.

Minor defects not exceeding 12.5 per cent of total metal thickness and which will not ultimately affect the strength and serviceability of the casting may be repaired by approved welding techniques. The Engineer shall be notified of larger defects and no repair welding of such defects shall be carried out without prior approval.

If the removal of metal for repair should reduce the stress resisting cross-section of the casting by more than 25 per cent, or to such an extent that the computed stress in the remaining metal exceeds the allowable stress by more than 25 per cent, then that casting may be rejected.

Castings repaired by welding for major defects shall be stress relieved after such welding.

Non-destructive tests will be required for any casting containing defects whose extent cannot otherwise be judged, or to determine that repair welds have been properly made.

4.6 Instrument Components

Iron and steel parts shall in general be painted or galvanised as appropriate in accordance with the Specification. Indoor parts may alternatively have chromium or copper-nickel plating or other approved protective finish.

Small iron and steel parts (other than stainless steel) of all instruments and electrical equipment, the poles of electro-magnets and the metal parts of relays and mechanisms shall be chromium or copper-nickel plated or have some other approved finish to prevent rust Cores, etc., which are built up of laminations or cannot for any other reason be antirust treated, shall have all exposed parts thoroughly cleaned and heavily enamelled, lacquered or compounded.

4.7 Safeguarding of Machinery

The Contractor shall ensure that all designs and equipment for which he is responsible are safe. Nothing in this Requirement shall remove the Contractors obligation from drawing the attention of the Engineer to any feature of the Works which is not consistent with safety, or to prevent him making proposals for incorporating equipment or designs which would increase the safety of the Plant.

The installation layout and plant design shall not allow any item of plant to be so positioned that danger to operating personnel could arise during normal operation and maintenance. Particular attention shall be paid to the position of hot pipes, air vents and rotating machinery.

All rotating shafts, couplings, gears, flywheels, belt drives or other moving parts shall be fully guarded. Guards shall be designed to provide ready access to bearings, grease points, thermometer sockets and other check points and to allow safe routine observation and servicing to be executed without the need to dismantle any part of their structure.

4.8 Rating Plates, Name plates and Labels

All equipment, apparatus and Plant shall be clearly labelled or fitted with nameplates and rating plates generally as follows:

4.8.1 Indoor Type Labels

(a) Labels for the outside of equipment shall be of a rigid type laminated and engraved plastic material, with black block capitals on a white background. The labels shall be fixed by non-rusting screws, or similar approved fixing device.

(b) Labelling inside equipment shall be as above except that a flexible self-adhesive type labelling may be used if suitable for the ambient temperatures and if not less than 12 mm in width.

4.8.2 Weatherproof Labels

These labels may be vitreous enamelled or brass. Plastic labels will not be accepted unless proof can be given that the labels can withstand the environmental conditions found at Site.

Vitreous enamelled labels shall be secured by brass or non-rusting roundhead screws, with brass and fibre washers in contact with the enamel front and back to prevent damage.

4.8.3 Name and Rating Plates

Each main and auxiliary item of Plant shall have permanently attached to it in a conspicuous position a nameplate and a rating plate. Upon these shall be engraved the manufacturer's name, type and serial number of Plant, details of the loading and duty at which the item of Plant has been designed to operate, and

such diagrams as may be required by the Engineer. All indicating and operating devices shall have securely attached to them or marked upon them a designation as to their function and proper manner of use. Provision shall be made to incorporate descriptive numbering codes as indicated on the Record Drawings. Details of proposed plates, labels and inscriptions shall be submitted to the Engineer for approval before manufacture.

4.9 Lubrication

A complete schedule of recommended oils and other lubricants shall be furnished by the contractor. The number of different types of lubricants shall be kept to a minimum. The schedule and the name of the supplier of the lubricants shall be submitted to the Engineer for approval before incorporation in the instruction manuals. In the case of grease lubricated roller type bearing for electric motors a lithium base grease is shall be used unless otherwise recommended by the manufacturer.

Where lubrication is effected by means of grease, preference shall be given to a pressure system which does not require frequent adjustment of recharging. Frequent, for this purpose means more than once a week and grease systems having shorter periods between greasings should be avoided. Where necessary for accessibility grease nipples shall be placed at the end of the extension piping, and, when a number of such points can be grouped conveniently, the nipples shall be brought to a common place mounted in a convenient position. Button head type nipples shall be used for normal grease and all grease nipples shall be of the same size and type for every part of the Plant. Arrangements shall be provided to prevent bearings being overfilled with either grease or oil.

Where more than one special grease is required a grease gun for each special type shall be supplied and permanently labelled.

Oil lubricated bearings shall be provided with an oil reservoir capable of automatically maintaining the correct oil level within the bearings. It must not be necessary to shut down the pump in order to see the oil level or to add oil to the bearings.

Oil sumps shall be fitted with oil level indicators of the sight glass type, or where this is not practicable, with dipsticks. The indicators shall show the level at all temperatures likely to be experienced in service. The normal, maximum and minimum levels at 20°C shall be clearly visible in the sight glass type from the normal access floor to the particular item of plant, and they shall be easily dismantled for cleaning.

All sight glasses shall be firmly held and enclosed in metal protection in such manner that they cannot be accidentally dislodged.

All lubrication systems shall be designed so as not to present a fire hazard and particular care shall be taken to prevent leakage of lubricants and to avoid leaking lubricants coming into contact with any electrical equipment, heated surfaces or another potential source of fire.

The Contractor shall supply flushing oil for each lubrication system when an item of plant is ready for preliminary running and a sufficient quantity of the approved lubricants for setting to work and for the commercial operation of the Plant for two years after the Taking over Certificate has been issued.

4.10 Initial Changes of Oil, Grease, etc.

The initial changes of oil, grease, electrolyte and similar materials necessary for the correct setting to work and operation of the Plant shall be included in the appropriate Plant item.

4.11 Non-metallic Materials

Fabrics, cork, paper and similar materials which are not subsequently to be protected by impregnation shall be treated, with an approved fungicide. Sleeving and fabrics treated with linseed oil varnish will not be permitted.

The use of organic materials shall be avoided as far as possible but where these have to be used they shall be treated to make them fire resistant and non-flame propagating.

The use of wood shall be avoided as far as possible. If used, woodwork shall be thoroughly seasoned teak or other approved hardwood which is resistant to fungal decay and other blemishes. All woodwork shall be treated to protect it against damage by fire, moisture, fungus, vermin, insect, bacteria or chemical attack, unless it is naturally resistant to all these. All joints in woodwork shall be dovetailed or tongued and pinned. Metal fittings on wood shall be of non-ferrous material. Adhesives shall be specially selected to ensure the use of types which are impervious to moisture and fungus growth. Synthetic resin cement shall be used for joining wood.

4.12 Engineering Hardware

Nuts, bolts, studs and washers for incorporation in the Works shall conform to the requirements of the appropriate British or other approved standard. Nuts and

bolts for pressure fittings shall be of the best quality steel machined on the shank and under the head and nut.
Bolts shall be of such a length that one thread shall show through the nut when in the fully tightened condition.

Fitted bolts shall be a light driving fit in the reamed holes they occupy, shall have the screwed portion of such a diameter that it will not be damaged in driving and shall be marked in a conspicuous position to ensure correct assembly at site.

Washers, locking devices and anti-vibration fittings shall be provided where necessary to ensure that no bending stress is caused in the bolt.

Where there is a risk of corrosion, bolts and studs shall be designed so that the maximum stress in the bolt does not exceed half the yield stress of the material under all conditions.
All bolts, nuts and screws which are subject to frequent adjustment or removal in the course of maintenance and repair shall be made of nickel-bearing stainless steel.

The Contractor shall supply all holding down, alignment and levelling bolts complete with anchorages, nuts, washers and packings required to attach the Plant to its foundation, and all bedplates, frames and other structural parts necessary to spread the loads transmitted by the Plant to concrete foundations without exceeding the design stresses.

Unless otherwise necessary to meet special requirements all thread shall be of preferred metric sizes with standard coarse threads.

ISO metric black hexagon bolts, nuts and screws shall comply with SII 0589-81, or ISO 885, ISO 888, ISO 898-1 and -2.

ISO metric precision hexagon bolts, nuts and screws shall comply with ISO 272, ISO 4759-1, ISO 885, ISO 888, ISO 898-1 and -2 or ASTM F-593, ASTM F-468 M, strength grade 8.8.

The dimensions of ISO metric countersunk head bolts screws, and hexagon nuts shall comply with ISO 225, or ISO 888, ISO 898-I.

Plain steel washers for use with ISO metric bolts shall comply with ISO 887 or ASTM F-844.

Taper steel washers shall comply with ASTM F-844 and ASTM F-436.

4.13 Instruments

Unless otherwise specified, any indicating and recording instruments supplied under the Contract shall be approved by the Engineer. They shall be flush-mounted pattern with dust- and moisture-proof covers and shall be suitable for the environment in which they are installed. Where hinged covers are necessary, they shall be provided with locks.

Indicating instruments shall be of the dial type and shall be provided with a readily accessible zero adjustment.

Dials in general shall be white with black markings and not subject to fading. Scales shall be of such material that no peeling or discoloration will take place with age under humid conditions.
Motor ammeters shall be capable of withstanding the starting current and shall have a compressed overload scale.

Steel screws, when used, shall be zinc, cadmium or chromium-plated, or where plating is not possible due to tolerance limitations, shall be of stainless steel. Instrument screws (except those forming part of a magnetic circuit) shall be of brass or bronze. Springs shall be non-rusting materials, e.g. phosphor-bronze or nickel-silver, as far as possible. Pivots and other parts for which non-ferrous material is unsuitable shall be of stainless steel.

Pressure gauges shall be not less that 150 mm diameter unless otherwise approved. The internal components shall be of stainless steel, bronze or some other corrosion resistant material other than aluminium. The gauges may be mounted directly on the pipework or side by side on a board or panel. Each pressure gauge shall be fitted with a stop cock immediately adjacent to the gauge, and all pressure gauge piping shall be fitted with an isolating valve at each point of connection to the main system. Where pressure gauges are mounted on panels, the isolating valve shall be suitable for the connection of a test gauge. Stop cocks of gauges shall be clearly identified by means of separate labels of approved type and lettering.

All fixed pipes below 25 mm nominal bore shall be compression jointed heavy gauge copper where this material is suitable. In other cases pipe materials are to be approved by the Engineer. All pressure gauges shall be fitted with an air release cock and hydraulic pressure snubbers to protect them against shock pressures.

4.14 Noise and Vibration

The noise level produced by any equipment like pump sets, compressor sets and blower sets shall not exceed 85 dBA measured at a distance of 1.86 m from the outline of the equipment. At the time of operation, the mechanical vibration shall not exceed the limits given below, at recommended points of measurement as per ISO 2372-1974 with Amendment 1-1983.

Equipment	Velocity of Vibration mm/sec
All rotating equipment not having reciprocating parts with motor KW less than or equal to 15 KW	1.12
All rotating equipment not having reciprocating parts with motor KW more than 15 KW and less than or equal to 75 KW	1.8
All rotating equipment not having reciprocating parts with motor KW greater than 75 KW	2.8

4.15 Pipe work and Layout

In general all pipes and fittings shall be steel or ductile iron with flanges to BS EN 1092-1/ BS 4504.

Where steel and cast flanges are mated together the steel flange shall be machined over its full face, after welding to its respective pipe is completed.

Flexible joints shall be provided to facilitate installation and removal and/or differential movement of plant. Where required, flexible joints shall be provided with tie bolts or other means to transfer longitudinal thrust along the pipe work as a whole.

The pipe work shall be laid out and designed such as to facilitate its erection, painting in situ, dismantling of any section for maintenance and to give a constant and uniform flow of working fluid with a minimum loss in head. Where steel pipe work is used the number of flanges is to be kept to a minimum with the size of each unit of pipe work determined by the ease of handling, installation and general appearance of the completed pipe system. Positions of flanges shall take into account any necessary concrete pipe supports or thrust blocks.

Facilities shall be provided for draining the pipe system. Where a pipe passes through a wall, retaining wall or is subject to thrust it shall incorporate a puddle flange which shall conform to the dimensions stated in BS EN 1092-1/ BS 4504 but remain undrilled.

Unless otherwise specified, nuts, bolts and washers for pipework shall conform to the requirements of BS EN 1092-1/BS 4504.

Bolts shall be of sufficient length that one thread shall show through the nut when in the fully tightened condition.

4.16 Gaskets and Joint Rings

Joint rings shall be manufactured to conform to BS 2494 and shall be of chloroprene rubber or other approved synthetic material suitable for temperatures up to 80°C.

Joints shall be made in accordance with manufacturer's instructions or as specified herein.

Until immediately required for incorporation in a joint, each rubber ring or gasket shall be stored in the dark free from the deleterious effects of heat or cold, and kept flat so as to prevent any part of the rubber being in tension.

Only lubricants recommended by the manufacturer shall be used in connection with rubber rings and these lubricants shall not contain any constituent soluble in water of the quality stated in the Requirements, shall be suitable for the climatic conditions at the Site and shall contain an approved bactericide.
After cleaning the flanges the gaskets shall be fitted smoothly to the flange and the joint made by tightening the nuts to finger pressure first. Thereafter the final tightening of the nuts shall be made by gradually and evenly tightening bolts in diametrically opposite positions using standard spanners.

Graphite grease shall be applied to the threads of bolts before joints are made.

4.17 Steelwork

Any small areas of chequer plating or similar covering that are necessary to cover gaps between items of Plant and the surrounding structure, and any access ladders, platforms and handrails that must be attached to items of Plant to facilitate operation, inspection or maintenance, shall be supplied and erected by the Contractor.

The Contractor shall include in his Contract for providing adequate means of access to all handwheels, sight glasses, gauges, lubrication points and any other items to which access is necessary for routine maintenance.

Handrails shall consist of double ball forged steel standards with tubular rails, hot dip galvanised in accordance with BS 729.

Chequer plating shall be of `Durbar' or other non-slip pattern, not less than 4.5 mm thick (exclusive of pattern) and hot dipped galvanised after fabrication in accordance with BS 729.

Aluminium alloy flooring may be offered as an alternative, manufactured in accordance with BS 1470, material H30 TB.

4.18 Protection and Packaging for Transportation

Before any Plant is despatched from a manufacturer's works it shall be properly prepared and packed.

Prior to despatch all Plant shall be adequately protected by painting or by other approved means for the whole period of, transit storages and erection, against corrosion and incidental damage, including the effects of vermin, sunlight, rain, high temperatures and humid atmospheres. The Contractor shall be held responsible for the Plant being so packed and/or protected as to ensure that it reaches the site intact and undamaged. The Plant shall be packed to withstand rough handling in transit and all packages shall be suitable for storage including possible delays in transit.

The Contractor shall be deemed to have included in the Schedule of Prices for all materials and packing cases necessary for the safe package, conveyance and delivery of the Plant.

The flanges of pipes, valves and fittings shall be protected by wooden discs attached by means of service bolts (which shall not be used at Site) or by other approved means. The sleeves and flanges of flexible couplings shall be bundled by wire. Cases containing rubber rings, bolts and other small items shall not normally weigh more that 500 kg gross.

No one package or bundle shall contain items of Plant intended for incorporation in more than one section of the Works. All items of Plant shall be clearly marked for identification against the packing list.

Every crate or package shall contain a packing list in a water proof envelope. A duplicate copy of the packing list shall be sent by post to the Engineer's Representative at Site.

All crates, packages, etc., shall be clearly marked with a waterproof material to show the weight, and where the slings should be attached, and shall also have an indelible identification mark relating them to the packing lists.

1.19 STRUCTURAL STEEL WORK

Applicable Codes and Specifications

The supply, fabrication, erection and painting of structural steel works shall comply with the following specifications, standards and codes unless otherwise specified herein. All standards, specifications and codes of practices referred to herein shall be the latest editions including all applicable official amendments and revisions.

1.	IS : 808	Dimensions for Hot Rolled Steel sections
2.	IS : 814	Covered Electrodes for Manual Metal Arc Welding of Carbon and Carbon Maganese Steel
3.	IS : 800	Code of Practice for General Construction in Steel
4.	IS : 801	Code of Practice for Use of Cold Formed Light Gauge Steel Structural Members in General Building Construction
5.	IS : 806	Code of Practice for Use of Steel Tubes in General Building Construction
6.	IS : 7205	Safety Code for Erection of Structural Steel Work
7.	IS : 7215	Tolerances for Fabrication of Steel Structures
8.	IS : 4000	High Strength Bolts in Steel Structure – Code of Practice
9.	AISC	Specifications for Design, Fabrication and Erection of Buildings
10.	IS : 1161	Steel Tubes for structural purposes
11.	IS:102	Ready Mixed paint, Brushing, Red Lead, Non-setting, Priming.
12.	IS:110	Ready Mixed paint, brushing, grey filler for enamels for use over primers.
13.	IS:117	Ready Mixed paint, Brushing, Finishing, Exterior Semigloss for general purposes, to Indian Standard colours.
14.	IS:158	Ready Mixed paint, Brushing, Bituminous, Black, Lead free, Acid, Alkali and heat resisting.
15.	IS:159	Ready Mixed paint, Brushing, Acid resisting for protection against acid fumes, colour as required.
16.	IS:341	Black Japan, Types A, B and C

17.	IS:2339	Aluminium paint for general purposes, in Dual container
18.	IS:2932	Specification for enamel, synthetic, exterior, type 1, (a) undercoating, (b) finishing
19.	IS:2933	Specification for enamel, exterior, type 2, (a) undercoating, (b) finishing
20.	IS:5905	Sprayed aluminium and zinc coatings on Iron and Steel.
21.	IS:6005	Code of practice for phosphating of Iron and Steel.
22.	IS:9862	Specification for ready mixed paint, brushing, bituminous, black, lead free, acid, alkali, water & chlorine resisting.
23.	IS:13183	Aluminium paint, Heat resistant.
24.	SIS-05-5900	(Swedish Standard)
25.	IS : 1239	Mild steel tubes, tubulars and other Wrought steel fittings Part 1 – Mild steel tubes Part 2 – Mild steel tubulars and other wrought steel pipe fittings
26.	IS : 1363 (Parts 1 to 3)	Hexagon Head Bolts, Screws and Nuts of product Grade C (Size range M5 to M64)
27.	IS : 1367 (All parts)	Technical Supply Conditions for Threaded Fasteners
28.	IS : 1852	Rolling and Cutting Tolerances for Hot Rolled Steel Products
29.	IS : 1977	Structural Steel (Ordinary Quality)
30.	IS : 2062	Steel for General Structural Purposes
31.	IS : 2074	Ready Mixed Paint, Air drying, Red Oxide Zinc Chrome and Priming
32.	IS : 3502	Steel Chequered Plate
33.	IS : 3757	High Strength Structural Bolts
34.	IS : 5369	General Requirements for Plain Washers and Lock Washers
35.	IS : 5372	Taper Washers for Channels
36.	IS : 5374	Taper Washer for 1 Beams
37.	IS : 6610	Heavy Washers for Steel Structures
38.	IS : 8500	Structural Steel-microalloyed (medium and high strength qualities)
39.	IS : 803	Code of practice for design, fabrication and erection of vertical mild steel cylindrical welded storage tanks
40.	IS : 816	Code of Practice for use of Metal Arc Welding for General construction in Mild Steel

41.	IS : 822	Code of Procedure for Inspection of Welds
42.	IS : 1182	Recommended Practice for Radiographic examination of Fusion – Welded Butt Joints in Steel Plates
43.	IS : 1200	Method of Measurement in Building Civil Works
44.	IS : 1477	Code of Practice for Painting of (Parts 1&2) Ferrous Metals in Buildings
45.	IS : 2595	Code of Practice for Radiographic Testing
46.	IS : 3658	Code of Practice for Liquid Penetrant Flaw Detection
47.	IS : 5334	Code of Practice for Magnetic Particle Flaw Detection of Welds
48.	IS : 9595	Recommendations for Metal Arc Welding of Carbon and Carbon Manganese Steel
49.	IS : 1367	Technical, Supply, Conditions for steel (Part 13) threaded fasteners
50.	IS : 1573	Electroplated Coating of Zinc on Iron and Steel
51.	IS : 2629	Recommended Practice for Hot Dip Galvanising of Iron and Steel
52.	IS : 2633	Method of Testing Uniformity of Coating on Zinc Coated Articles
53.	IS : 4736	Hot Dip Zinc coating on Mild steel tubes
54.	IS : 4759	Hot Dip Zinc coating on Structural Steel and other Allied products
55.	IS : 5905	Sprayed Aluminium and Zinc Coatings on Iron and Steel
56.	IS : 6158	Recommended Practice for Safeguarding against Embrittlement of Hot Dip Galvanised Iron and Steel
57.	IS : 6159	Recommended Practice for Design and preparation of Material Prior to Galvanising
58.	IS : 6745	Methods for Determination of Weight of Zinc Coating on Zinc coated Iron and Steel Articles

Steel Materials

Steel materials shall comply with the codes referred to in Sub-Clause 6.1.

All materials used shall be new, unused and free from defects.

Steel conforming to IS:1977 shall be used only for the following :

Fe310-0(St 32-0)	For general purposes such as door/window frames, grills, steel gates, handrails, fence posts, tee bars and other non-structural use.
Fe410-0(St 42-0)	For structures not subjected to dynamic loading other than wind loads such as :

	Platform roofs, foot over bridges, building, factory sheds etc.
Fe10-0(St 42-0)	Grade steel shall not be used
	a) If welding is to be employed for fabrication b) If site is in severe earthquake zone c) If plastic theory of design is used

Drawings prepared by the Employer

Design drawings will be furnished to the Contractor and all drawings so furnished shall form a part of this specification in case of Item Rate Contracts. These design drawings prepared by the Engineer will show all the levels, forces on members where shall necessary, size and orientation of each member, location/size of openings to enable the Contractor to prepare drawings for fabrication and erection. It shall be clearly understood that these drawings are not intended to show connection details, thickness of members, cuts, notches, bends and such other details.

The Engineer reserves the right to make changes. Revisions to drawings, even after release for preparation of shop drawings, are very likely to be made to reflect additional data/details received and updated requirements. Revisions to drawings and any new drawings made to include additional work by the Contractor shall be considered a part of this specification and contract. The Employer shall not entertain any extra claims on this account.

Where the fabrication drawings are to be furnished by the Engineer, he will issue to the Contractor the required copies of such drawings in the sequence required for the fabrication of the components in the order they will be required to be erected at site. Such drawings will be issued in such numbers as required for the Contractor to adhere to the project schedule.

Should the Contractor during the execution of his work, find discrepancies in the information furnished by the Engineer, he shall refer such discrepancies to the Engineer before proceeding with the work.

Drawings prepared by the Contractor

The Contractor shall prepare all fabrication and erection drawings for the entire work. All the drawings for the entire work shall be prepared in metric units.

The drawings shall preferably be of one standard size and the details shown there in shall be clear and legible.

The Contractor shall not commence detailing unless Engineer's design drawings are officially released for preparation of shop drawings. The Contractor shall be responsible for the correctness of all fabrication drawings. Fabrication drawings shall be revised by the Contractor to reflect all revisions in design drawings as and when such revisions are made by the Engineer.

All fabrication drawings shall be submitted to the Engineer for approval.

No fabrication drawings will be accepted for Engineer's approval unless checked and approved by the Contractor's qualified structural engineer and accompanied by an erection plan showing the location of all pieces detailed. The Contractor shall ensure that connections are detailed to obtain ease in erection of structures and in making field connections.
Fabrication shall be started by the Contractor only after Engineer's approval of fabrication drawings. Approval by the Engineer of any of the drawings shall not relieve the Contractor from the responsibility for correctness of engineering and design of connections, workmanship, fit of parts, details, material, errors or omissions of any and all work shown thereon. The Engineer's approval shall constitute approval of the size of members, dimensions and general arrangement but shall not constitute approval of the connections between members and other details.

The drawings prepared by the Contractor and all subsequent revisions etc. shall be at the cost of the Contractor for which no separate payment will be made.

Fabrication

General

All workmanship and finish shall be of the best quality and shall conform to the best approved method of fabrication. All materials shall be finished straight and shall be machined/ground smooth true and square where so specified. All holes and edges shall be free of burrs. Shearing and chipping shall be neatly and accurately done and all portions of work exposed to view shall be neatly finished. Unless otherwise approved by the Employer's Representative, reference may be made to relevant IS codes for providing standard fabrication tolerance. Material at the shops shall be kept clean and protected from weather.

Connections

Shop/field connections shall be as per approved fabrication drawings.

In case of bolted connections, taper washers or flat washers or spring washers shall be used with bolts as necessary. In case of high strength friction grip bolts, hardened washers be used under the nuts or the bolt heads whichever are turned to tighten the bolts. The length of the bolt shall be such that atleast one thread of the bolt projects beyond the nut, except in case of high strength friction grip bolts where this projection shall be at least three times the pitch of the thread.

In all cases where bearing is critical, the unthreaded portion of bolt shall bear on the members assembled. A washer of adequate thickness may be provided to exclude the threads from the bearing thickness, if a longer grip bolt has to be used for this purpose.

All connections and splices shall be designed for full strength of members or loads. Column splices shall be designed for the full tensile strength of the minimum cross section at the splice.

All bolts, nuts, washers, electrodes, screws etc., shall be supplied/brought to site 10% in excess of the requirement in each category and size. Rates shall cover the cost of this extra quantity.

All members likely to collect rain water shall have drain holes provided.

Straightening

All materials, shall be straight and, if necessary, before being worked shall be straightened and/or flattened by pressure and shall be free from twists. Heating or forging shall not be resorted to without the prior approval of the Employer’s Representative in writing.

Rolling and Forming

Plates, channels, R.S.J. etc., for circular bins, bunkers, hoppers, gantry girders, etc., shall be accurately laid off and rolled or formed to required profile/shape as called for on the drawings. Adjacent sections shall be match-marked to facilitate accurate assembly, welding and erection in the field.

High Strength Friction Grip Bolting

Inspection after tightening of bolts shall be carried out as stipulated in the appropriate standards depending upon the method of tightening and the type of bolt used.

Welding

Welding procedure shall be submitted to the Employer's Representative for approval. Welding shall be entrusted to qualified and experienced welders who shall be tested periodically and graded as per IS 817, IS : 7310 (Part 1) and IS : 7318 (Part 1).

While fabricating plated beams and built up members, all shop splices in each component part shall be made before such component part is welded to other parts of the members. Wherever weld reinforcement interferes with proper fit-up between components to be assembled off welding, these welds shall be ground flush prior to assembly.

Approval of the welding procedure by the Employer's Representative shall not relieve the Contractor of his responsibility for correct and sound welding without undue distortion in the finished structure.

No welding shall be done when the surface of the members is wet nor during periods of high wind.

Each layer of a multiple layer weld except root and surfaces runs may be moderately peened with light blows from a blunt tool. Care shall be exercised to prevent scaling or flaking of weld and base metal from overpeening.

No welding shall be done on base metal at a temperature below –5 Deg.C. Base metal shall be preheated to the temperature as per relevant IS codes.

Electrodes other than low-hydrogen electrodes shall not be permitted for thicknesses of 32 mm and above.

All welds shall be inspected for flaws by any of the methods described under Sub-clause 6.8.3. The choice of the method adopted shall be agreed with the Employer's Representative.

The correction of defective welds shall be carried out in a manner approved by the Employer's Representative without damaging the parent metal. When a crack in the weld is removed, magnetic particle inspection or any other equally

positive means approved by the Employer's Representative shall be used to ensure that the whole of the crack and material upto 25 mm beyond each end of the crack has been removed. The cost of all such tests and operations incidental to correction shall be borne by the Contractor.

Tolerances

The dimensional and weight tolerances for rolled shapes shall be in accordance with IS : 1852 for indigenous steel and equivalent applicable codes for imported steel. The tolerances for fabrication of structural steel shall be as per IS : 7215.

Cutting, punching, drilling, welding and fabrication tolerances shall be generally as per relevant IS codes.

End Milling

Where compression joints are specified to be designed for bearing, the bearing surfaces shall be milled true and square to ensure proper bearing and alignment.

Inspection

General

The Contractor shall give due notice to the Employer's Representative in advance of the works being made ready for inspection. All rejected material shall be promptly removed from the shop and replaced with new material for the Employer's Representative's inspection. The fact that certain material has been accepted at the Contractor's shop shall not invalidate final rejection at site by the Employer's Representative if it fails to conform to the requirements of these specifications, to be in proper condition or has fabrication inaccuracies which prevent proper assembly nor shall it invalidate any claim which the Employer may make because of defective or unsatisfactory materials and/or workmanship.

No materials shall be painted or despatched to site without inspection and approval by the Employer's Representative unless such inspection is waived in writing by the Employer's Representative.

The Contractor shall provide all the testing and inspection services and facilities for shop work except where otherwise specified.

For fabrication work carried out in the field the same standard of supervision and quality control shall be maintained as in shop fabricated work. Inspection and testing shall be conducted in a manner satisfactory to the Employer's Representative.

Inspection and tests on structural steel members shall be as set forth below.

Material Testing

If mill test reports are not available for any steel materials the same shall be tested by the Contractor to the Employer's Representative's satisfaction to demonstrate conformity with the relevant specification.

Tests on Welds

Magnetic Particle Test

Where welds are examined by magnetic particle testing, such testing shall be carried out in accordance with relevant IS codes. If heat treatment is performed, the completed weld shall be examined after the heat treatment. All defects shall be repaired and retested. Magnetic particle tests shall be carried out using alternating current. Direct current may be used with the permission of the Employer's Representative.

Liquid Penetrant Inspection

In the case of welds examined by Liquid Penetrant Inspection, such tests shall be carried out in accordance with relevant IS Code. All defects shown shall be repaired and rechecked.

Radiographic Inspection

All full strength butt welds shall be radiographed in accordance with the recommended practice for radiographic testing as per relevant IS code.

Dimensions, Workmanship & Cleanliness

Members shall be inspected at all stages of fabrication and assembly to verify that dimensions, tolerances, alignment, surface finish and painting are in

accordance with the requirements shown in the Contractor's approved fabrication drawings.

Test Failure

In the event of failure of any member to satisfy inspection or test requirement, the Contractor shall notify the Employer's Representative. The Contractor must obtain permission from the Employer's Representative before any repair `is undertaken. The quality control procedures to be followed to ensure satisfactory repair shall be subject to approval by the Employer's Representative.

The Employer's Representative has the right to specify additional testing as he deems necessary, and the additional cost of such testing shall be borne by the Employer, only in case of successful testing.

The Contractor shall maintain records of all inspection and testing which shall be made available to the Employer's Representative.

Shop Matching

For structures like bunkers, tanks, etc. shop assembly is essential. For other steel work, such as columns along with the tie beams/bracings may have to be shop assembled to ensure satisfactory fabrication, obtaining of adequate bearing areas etc., if so desired by the Employer's Representative. All these shop assemblies shall be carriedout by the Contractor.

Marking of Members

After checking and inspection, all members shall be marked for identification during erection. This mark shall correspond to distinguishing marks on approved erection drawings and shall be legibly painted and stamped on it. The erection mark shall be stamped with a metal dye with figures at least 20 mm high and to such optimum depth as to be clearly visible.

All erection marks shall be on the outer surface of all sections and near one end, but clear of bolt holes. The marking shall be so stamped that they are easily discernible when sorting out members. The stamped marking shall be encircled boldly by a distinguishable paint to facilitate easy location.

Erection marks on like pieces shall be in identical locations. Members having lengths of 7.0 m or more shall have the erection mark at both ends.

Errors

Any error in shop fabrication which prevents proper assembling and fitting up of parts in the field by moderate use of drift pins or moderate amount of reaming will be classified by the Employer's Representative as defective workmanship. Where the Employer's Representative rejects such material or defective workmanship, the same shall be replaced by materials and workmanship conforming to these Employer's Requirements by the Contractor, at no cost to the Employer.

Site Operations

The Contractor shall complete all preliminary works at site well before the arrival of structural steel, such as establishment of a well equipped and adequately staffed site office, stores, unloading gantry, unloading pre-assembly yard, labour quarters if any, electrical and water connections, electrical winches, derricks, cranes, compressors, all tools and tackles, rivet guns, welding sets, torque wrenches, spud wrenches, staging, etc., as well as experienced erection and supervisory personnel as part of this contract and any other work that may be necessary so as to start erection immediately after the arrival of the first batch of steel on site.

The Contractor shall furnish at his own expense, the necessary non-inflammable staging and hoisting materials or equipment required for the erection work and shall remove and take them away after completion of the job. The Contractor shall also provide necessary passageways, fences, safety belts, helmets, lights and other fittings to the satisfaction of the Employer's Representative and to meet the rules of local authorities and for protection to his men and materials. A licensed electrician shall be kept on the job for the entire duration of the work to maintain the Contractor's electrical equipment and connections.

The Contractor shall protect all existing plant, structures, piping, conduits, equipment and facilities against damage during erection. Any damage caused by contractor shall be rectified entirely at his cost, to the satisfaction of the Employer's Representative. If work has to be carried out adjacent to existing switch yards or electrical installations which are live, the Contractor must ensure suitable safety precautions in consultation with Employer's Representative.

If a portion of the work of the project area cannot be made available to the Contractor for his activities due to operations being carried out by other agencies, he shall suitably modify his sequence of operations so as to continue work without interruption. The Contractor shall work in co-ordination with other agencies working on the project site and plan his work suitably so as not to hinder the progress of construction at site.

Acceptance of Steel, its Handling & Storage

The Contractor shall carefully check the steel to be erected at the time of acceptance. Any fabrication defects observed should be brought to the notice of the Employer's Representative.

No dragging of steel shall be permitted. All steel shall be stored 300mm above ground on suitable packing to avoid damage. It shall be stored in the order required for erection, with erection marks visible. All storage areas shall be prepared and maintained by the Contractor. Steel shall not be stored in the vicinity of areas where excavation or grading will be done and, if so stored temporarily, this shall be removed by the Contractor well before such excavation and/or grading commences to a safe distance to avoid burial under debris.

Scratched or abraded steel shall be given a coat of primer in accordance with these Employer's Requirements for protection after unloading and handling prior to erection. All milled and machined surfaces shall be properly protected from rust/corrosion by suitable coating and also from damage.

Anchor Bolts & Foundations

The Contractor shall carefully check the location and layout of anchor bolts embedded in foundations constructed, to ensure that the structures can be properly erected as shown on the drawings. Any discrepancy in the anchor bolts/foundation shall be reported to the Employer's Representative.

Leveling of column bases to the required elevation may be done either by providing shims or three nuts on the upper threaded portion of the anchor bolt. All shim stock required for keeping the specified thickness of grout and in connection with erection of structures on foundations, crane brackets or at any other locations shall be of good M.S. plates and shall be supplied by the Contractor at his cost.

A certain amount of cleaning of foundations and preparing the area is considered normal and shall be carried out by the Contractor at no extra cost.

Where beams bear in pockets or on walls, bearing plates shall be set and levelled as part of the work. All grouting under column base plates or beam bearing plates will be carried out by the Contractor.

Assembly & connections

Field connections may be effected either by riveting, bolting, welding or by use of high strength friction grip bolts as shown on the design and erection drawings.

All field connection work shall be carried as per the drawings prepared by the Contractor. All bolts, nuts, washers, rivets, electrodes required for field connections shall be supplied by the Contractor.

All assembling shall be carried on a level platform.

Drifts shall be used only for drawing the work to proper position and must not be used to such an extent as to damage the holes. Size of drifts larger than the normal diameter of hole shall not be used. Any damaged holes or burrs must be rectified to the satisfaction of the Employer's Representative.

Corrections of minor misfits and reasonable amount of reaming and cutting of excess stock from rivets shall be considered as a part of erection. Any error in the shop, which prevents proper fit on a moderate amount of reaming and slight chipping or cutting, shall be immediately reported to the Employer's Representative.

Erection

All structural steel shall be erected as shown on the drawings prepared by the Contractor. Proper size steel cable slings, etc., shall be used for hoisting. Guys shall not be anchored to existing structures, foundations, etc., unless so permitted by the Employer's Representative in writing. Care shall be taken to see that ropes in use are always in good condition.

Steel columns in the basement, if any, are to be lowered and erected carefully with the help of a crane and/or derrick without damaging the basement walls or floor.

Structural steel frames shall be erected plumb and true. Frames shall be lifted at points such that they are not liable to buckle and deform. Trusses shall be lifted only at node points. In the case of trusses, roof girders, all of the purlins

and wind bracing shall be placed simultaneously and the columns shall be erected truly plumb on screed bars over the pedestals. All steel columns and beams shall be checked for plumb and level individually before and after connections are made. Temporary bracings shall be introduced wherever necessary to take care of all loads to which the structure may be subjected, including erection equipment and the operation thereof. Such bracings shall be left in place as long as may be required for safety and stability.

Chequered plates shall be fixed to supporting members by tack welding or by countersunk bolts as shown/specified in relevant drawings and/or as approved by the Employer's Representative. The edges shall be made smooth and no burrs or jagged ends shall be left. While splicing, care should be taken so that there is continuity in pattern between the two portions. Care should also be taken to avoid distortion of the plate while welding. The erection of chequered plates shall include:

(a) Welding of stiffening angles/vertical stiffening ribs
(b) Cutting to size and making holes to required shape wherever necessary to allow service piping and/or cables to pass through
(c) Splicing as shown in relevant drawings
(d) Smoothening of edges
(e) Fixing of chequered plates by tack welding or by countersunk bolts
(f) Providing lifting hooks for ease of lifting.

As erection progresses, the work shall be securely bolted to take care of all dead load, wind, seismic and erection stresses.

No riveting or welding or final bolting shall be done until the structure has been properly aligned and approved by the Employer's Representative. No cutting, heating or enlarging of the holes shall be carried out without the prior written approval of the Employer's Representative.

Test certificates shall be furnished by the Contractor.

Inspection

The Employer's Representative shall have free access to all parts of the job during erection and all erection shall be subjected to his approval. In case of faulty erection, all dismantling and re-erection required will be at the Contractor's cost. No paint shall be applied to rivet heads or field welds or bolts until these have been approved by the Employer's Representative.

Tolerances

General

Tolerances mentioned below shall be achieved after the entire structure or part thereof is in line, level and plumb.

Columns

Deviation of column axes at foundation top level with respect to true axes :

(a) In longitudinal direction	±5 mm
(b) In lateral direction	±5 mm

Deviation in the level of bearing surface of columns at foundation top with respect to true level	±5mm

Out of plumbness (verticality) of column axis from true vertical axis, as measured at column top :

(a)	For columns upto and including 15 metres in height	±1/1000 of column height in mm or ±15 mm whichever is less
(b)	For columns exceeding 15 metres in height	±1/1000 of column height in mm or ±20 mm whichever is less

Deviation in straightness in longitudinal and transverse planes of column at any point along the height	±1/1000 of column height in mm or ±10 mm whichever is less

Difference in erected position of adjacent pairs of columns along length or across width of building prior to connecting trusses/beams with respect to true distance	±10mm

Deviation in any bearing or seating level with respect to true level	±5 mm

Deviation in differences in bearing level of a member on adjacent pair of columns	±10 mm

both across and along the building	
Trusses And Beams	
Shift at the centre of span of top chord member with respect to the vertical plane passing through the centre of bottom chord	±1/250 of height of truss in mm or ±15 mm whichever is less
Lateral shift of top chord of truss at the centre of span from the vertical plane passing through the centre of supports of the truss	±1/1500 of span of truss in mm or ±15 mm whichever is less
Lateral shift in location of truss from its true vertical position	±10 mm
Lateral shift in location of purlin true position	±5 mm
Deviation in difference of bearing levels of trusses or beams from the true difference	i) ±20 mm for trusses ii) For beams : Depth < 1800mm : ±6mm Depth > 1800mm : ±10mm
Deviation in sag in chords and diagonals of truss between node points	1/1500 of length in mm or 10mm whichever is smaller
Deviation in sweep of trusses, beams etc. subject in the horizontal plane	1/1000 of span in mm to a maximum of 10 mm
Crane Girders & Rails	
Shift in the centre line of crane rail with respect to centre line of web of crane girder	±5 mm
Shift in plan of alignment of crane rail with	±5 mm

respect to true axis of crane rail at any point	
Difference in alignment of crane rail in plan measured between any two points 2 metres apart along rail	±1 mm
Deviation in crane track with respect to Time gauge	
(a) For track gauges upto and Including 15 metres	±5 mm
(b) For track gauges more than 15 metres	± [5 + 0.25 (S-15)] where S in metres is true gauge
Deviation in the crane rail level at any distance or point from true level	±1/1200 of the gauge ±10mm whichever is less
Difference in the crane rail actual levels between any two points 2 metres apart along the rail length	±2 mm
Difference in levels between crane track Rails at	
(a) Supports of crane girders	±15 mm
(b) Mid span of crane girders	± 20 mm
Relative shift of crane rail surfaces at a joint in plane and elevation	2 mm subject to grinding of surfaces for smooth transition
Relative shift in the location of crane stops (end buffers) along the crane tracks with track gauge S in mm	1/1000 of track gauge S in mm subject to maximum of 20 mm

Clean up of Work site

During erection, the Contractor shall at all times keep the working and storage areas used by him free from accumulation of waste materials or rubbish. Before completion of erection, he shall remove or dispose of in a satisfactory manner

all temporary structures, waste and debris and leave the premises in a condition satisfactory to the Employer's Representative.

Painting

General

After steel has been erected, all bare and abraded spots, rivet heads, field welds, bolt heads and nuts shall be spot painted with primer. Before paint is applied, the surface shall be dry and free from dust, dirt, scale and grease. All surfaces inaccessible after erection shall receive two coats of the approved paint before erection.

Surface Treatment

All the surfaces of steel work to be painted shall be thoroughly cleaned of all loose mill scale, rust, grease, dirt and other foreign matter. The workmanship shall generally conform to the requirements of IS 1477- Part I.

Oil and grease removal shall be carried out either by solvent cleaning or by using alkali type degreasing agents. To remove grease material the surface shall be cleaned with solvents containing emulsifier. After cleaning, the surface shall be washed with water. When the surface has cement pelter or salts, the cleaning shall be done with strong alkalies. After cleaning, water rinsing and subsequent passivation by dilute chromic acid rinsing shall be carried out to ensure that no traces of alkali is left on the surface. The procedure for cleaning by above mentioned methods shall be as per manufacturer's instructions.

Derusting and descaling of steel shall be carried out either manually, mechanically or chemically.

Manual or Hand Tool Cleaning

Loose mill scale, loose rust and loose paint shall be removed by wire brushing, scrapping, chipping, rubbing with abrasive paper or steel wool. This method shall not be employed when the surface has firmly adhering mill scale. After hand tool cleaning, the surface shall be rubbed with sand paper so as to ensure that no loose material exists and the surfaces shall be dusted off.

Mechanical Cleaning

Power Tool Cleaning

This shall be carried out by employing power operated wire brushes. Power tool cleaning shall be resorted to only if sand/shot blasting is not possible/permissible and high quality of surface preparation is required.

The surface prior to treatment shall have been cleaned of dust and grease and heavier layers of rust removed by chipping.

The powertool cleaning shall remove loose mill scale and rust by adopting very thorough scrapping, grinding and machine brushing. After the surfaces are cleaned by compressed air, it shall have a pronounced metallic sheen.

Flame Cleaning

Hard mill scale and rust shall be removed through Oxy- acetylene flame. The work shall be carried out by trained workmen to ensure that only mill scale is removed without heating the parent steel. The work shall be carried out carefully on welded surfaces so that the strength of weld is not affected due to heating.

Sand Blasting and Shot Blasting

Sand/shot blasting shall only be carried out after removal of grease, oil and other contaminants. The work shall be carried out by impinging under pressure of air, a jet of sharp sand or granulated steel (steel grits) on to the metal surface. The process shall ensure complete removal of rust and firmly adhering mill scale. Special care shall be taken on weld areas to remove flux and spatter. Blasting shall ensure an even colour of the surface and the surface shall have silver grey colour. Precautions shall be taken when sand or shot blasting of light gauge steel surfaces to ensure that buckling does not occur due to continuous impingement of sand or steel shots under high velocity.

Sand/shot blasting shall be adopted for structures which are exposed to corrosive conditions for which superior paint protection is to be adopted. The finished surfaces shall conform to the requirements of Sa 2.5 or Sa 3 as per Swedish Standard SIS-05-5900 as required.

As sand blasting causes dust nuisance, necessary clearance shall be obtained by the Contractor from the Competent authorities prior to commencing sand blasting.

Chemical Cleaning (Pickling)

The cleaning shall be done by pickling in sulphuric, hydrochloric or phosphoric acids. Pickling shall be carried out in accordance with detailed procedure as given in IS 6005.

Washing after pickling shall remove all traces of the acids. All work pieces shall be thoroughly inspected and in particular the inaccessible corners.

All surfaces shall be cleaned thoroughly as per manufacturers specification before application of primer.

Materials

Primer paint

Anti-corrosive primers shall be either lead based or lead free types. Red lead primer shall conform to IS 102 and red oxide zinc chrome primer shall conform to IS 2074.

Finish Paint

Epoxy primer and epoxy paint shall be of the type as specified from an approved manufacturer.

Chlorinated rubber based paint shall be of the manufacture as specified or any equivalent approved manufacture.

All the materials shall be of the best quality from an approved manufacturer. The Contractor shall obtain prior approval of the Employer’s Representative for the brand of manufacture and the colour/shade prior to procurement for usage in the works.

Primer and finish paints shall be compatible with each other to avoid cracking and wrinkling. As such it is recommended that the primer and finish paint shall be from the same manufacturer.

The colour and shade shall be conforming to IS Standards referred to in Appendix 'D' of IS 1477-Part II. To facilitate choosing the correct shade number from the alternatives available, the Contractor shall adopt trial painting in small patches in consultation with and as approved by the Employer’s Representative.

All paint delivered to the fabrication shop/site shall be ready mixed, in original sealed containers, as packed by the manufacturer. Thinner shall not be

permitted for usage unless specifically approved so by the Employer's Representative.

Paints shall be stirred thoroughly to keep the pigment in suspension.

The Contractor shall arrange for testing of paints as per relevant Indian Standards in an approved laboratory whenever the Employer's Representative requires the tests to be carried out for each batch of paints. Test results shall be submitted to the Employer's Representative for approval.

Workmanship

The type and the number of coats of the primer paint and finish paint shall be as specified.

Painting shall be carried out only on thoroughly dry surfaces.

No painting shall be done in frosty/foggy weather or when the humidity is high enough to cause condensation on the surface to be painted. Paint shall not be applied when the temperature of the surface to be painted is at 5deg.C or lower.

Primers shall adhere to the surface firmly and offer a key to the subsequent coats.

Workmanship shall generally conform to requirements specified in IS:1477-Part II.

It is essential to ensure that immediately after preparation of the surfaces, the first coat of primer paint shall be applied by brushing and working it well to ensure a continuous film. After the first coat becomes hard dry a second coat of primer shall be applied by brushing.

Structural steel surfaces shall be given the first coat of primer at shop and the second coat after it is erected in position. Further, any abraded surfaces of the first coat during transport from shop to site and during erection shall be provided with a touch-up coat of the primer.

The dry film thickness of each coat of primer shall be not less than 25 microns.

Application of finishing paints shall be carried out within the shortest possible time interval after primer since the primer coats are too thin to give adequate corrosion protection of the steel surface over a long duration.

Filler coats shall be applied to fill dents and to obtain a smooth finish wherever necessary. Only factory prepared filler suitable for steel work shall be used. Fillers prepared by whiting and linseed oil by craftsmen at site shall not be used. Application of filler shall be done with good `putty knife' and necessary skill. Filler applied shall be just sufficient to fill the depression or unevenness and it shall be restricted to the minimum. It shall be applied in thin layers. In filling depression or unevenness, as many coats as are necessary may be applied allowing each layer to dry hard. The hardened coat shall be cut down by wet rubbing before the subsequent coat is applied. Where necessary, filler coats shall be applied over the undercoats also.

Painting shall be carried out either by brushing or by spraying. The Contractor shall procure the appropriate quality of paint for this purpose as recommended by the manufacturer.

After the second coat of primer is hard dry, the entire surface shall be wet rubbed cutting down to a smooth uniform surface. When the surface becomes dry, the undercoat of paint of optimum thickness shall be applied by brushing/spraying with minimum of brush marks. The coat shall be allowed to hard-dry. The under coat shall then be wet rubbed cutting down to a smooth finish, taking adequate care to ensure that at no place the undercoat is completely removed. The surface shall then be allowed to dry.

The first finishing coat of paint shall be applied by brushing or by spraying and allowed to hard-dry. The gloss from the entire surface shall then be gently removed and the surface dusted off. The second finishing coat shall then be applied by brushing or by spraying.

At least 24 hours shall elapse between the application of successive coats. Each coat shall vary slightly in shade and shall be approved by the Employer’s Representative, prior to applying the next coat.

Minimum dry film thickness of each coat of finish paint of synthetic enamel shall be 25 microns. Minimum dry film thickness of other finish paints shall be as specified in the respective item of work.

The thickness of film shall be measured by an Elcometer to be supplied by the Contractor. The Contractor shall calibrate the Elcometer frequently for different settings. Necessary calibrating accessories should be kept ready for calibration / testing of the Elcometer at any time.

Epoxy primer and epoxy paint shall be applied within the specified pot life all as per recommendations of the manufacturer.

Surfaces inaccessible after assembly shall receive two coats of primer prior to assembly.

Surfaces inaccessible after erection, including top surfaces of floor beams, supporting grating or chequered plate shall receive one additional coat of finish paint over and above the number of coats specified prior to erection.

Portion of steel members embedded/to be encased in concrete shall not be painted. Joints to be site welded shall have no shop paint for atleast 50mm from the welding zone. Similarly, the steel surfaces shall not be painted in areas where connection is by use of friction grip bolts. On completion of the joint, the surfaces shall received the painting as specified.

Maintenance painting of steel structures will become necessary if the painting already carried out shows signs of chalking, hairline cracking, deep checking, fine checking, peeling, blistering and rusting. It is essential that same quality of paint as specified earlier need be adopted to ensure compatibility. The general workmanship for maintenance painting shall conform as per Clause.7 of IS 1477 – Part II.

The Contractor shall provide suitable protection as necessary to prevent paint finishes from splashing on equipment, floors, walls, etc.

Method of Measurement

For the purpose of payment, the weight of the actual, completed structures shall be calculated from the approved drawings for different items of work. Contractor shall submit to Employer relevant material list containing weight of each item.

No allowance will be permitted for weights of rivets, bolts, washers, screws etc. in calculating the weight of the completed structure. No allowances will be permitted for galvanizing, welding or for rolling margins. One tonne for the purpose of payment shall mean One Metric Tonne i.e. 1000 kg.

The weight of a member made out of standard rolled sections such as beams, channels, angles, etc. shall be based on the weight of the member given in IS 808, without deducting for hole, notches, bevel cuts, etc. Where a component consists of a cut joist or channel, the full weight of the rolled section shall be considered only if more than half the depth of the section is used. Otherwise

only half the section unit weight shall be taken. Deductions shall be made in the weight of gussets/plates including chequered plates for skew cuts, notches and openings of 900 sq.cm. or larger.

For gussets/plates used in trusses, bracings, columns, beams etc. the area shall be that of the minimum circumscribing rectangle, except as stated above.

The weight of any built-up member shall be separated into the weight of each component.

Erection bolts installed by erector may be left in position on completion of erection; however, no additional payment shall be made either for supply or use of such bolts. If erection bolts are removed after erection is complete, holes shall be plug welded and ground smooth. No extra payment shall be made for such plug welding.

Painting work shall not be measured separately, if primer painting and/or primer and finish painting is deemed to be included in the scope of the item of work of fabrication and erection of structural steel since the rate per tonne of steel is deemed to include for painting as specified.

In cases where primer and/or finish painting work as specified is carried out on erected structural steel executed by a different agency, the method of measurement for painting shall be on the basis of tonnage of steel erected. For this purpose, the tonnage of erected steel as certified for payment to the different agency shall be considered as the basis and no measurement will be carried out separately.

Galvanising of Structural Steel

Galvanising Plant

Prior approval shall be obtained from Employer / Engineer if galvanising is proposed to be carried out outside Contractor’s plant.

Workmanship

After all shop work is complete, all structural materials shall be punched with the erection mark and be hot-dip galvanised. Before galvanising, the steel shall be thoroughly cleaned of any paint, grease, rust, acid or alkali or such other foreign matters as are likely to interfere with the galvanising process or with the quality and durability of the zinc coating. Pickling shall be very carefully done and shall be proper.

The weight of the zinc coating shall be at least 0.610 kg/sq.m unless specified otherwise. Stub members and members for grillage type footing shall have heavier zinc coating not less than 0.80 kg/sq.m.

The galvanised surface shall consist of a continuous and uniformly thick coating of zinc, firmly adhering to the surface of steel. The finished surface shall be clean and smooth, and shall be free from defects like discoloured patches, bare spots, unevenness of coating, spelter which is loosely attached to the steel, globules, spiky de S:2633 unless specified otherwise.

All galvanised members shall be treated with Sodium dichromate solution or an approved equivalent after galvanising, so as to prevent white storage stains.

Galvanising of each member shall be carried out in one complete immersion. Double dipping shall not be permitted. However, in case of members over 7.5 M long, the Contractor shall take prior approval of Engineer for double dipping. When the steel section is removed from the galvanising kettle, excess spelter shall be removed by 'bumping'.

Wherever galvanised bolts, nuts locknuts, washers, accessories etc. are specified, they shall be hot-dip galvanised. Spring washers shall be electro-galvanised. Excess spelter from bolts, nuts, etc. shall be removed by centrifugal spinning. Rechasing of bolt threads after galvanising shall not be permitted. Nuts, however, may be tapped, but not to cause appreciable rocking of the nuts on the bolts. Readily available GI nuts, bolts and washers conforming to galvanising requirements may also be used.

Defects in certain members indicating presence of impurities in the galvanising bath in quantities larger than that permitted by the specifications, or lack of quality control in any manner in the galvanising plant, shall render the entire production in the relevant shift liable to rejection.

Contractor shall ensure that galvanising is not damaged in transit. In the event of occurrence of any damages Contractor shall at his own cost adopt scrapping and regalvanising the member to satisfy the specific requirements.